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The early lithic productions of Island Southeast Asia: traditions or convergences?

Les premières productions lithiques de l'Asie du Sud-Est insulaire : traditions ou convergences ?

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Abstract

Island Southeast Asia has been the subject of intense prehistoric investigations since the seminal work of Eugene Dubois in the late XIXth century. This has resulted in several discoveries of a very diverse type of lithic productions of oftentimes debated age. Recent and old excavations have now secured the production of stone artefacts as early as 1 million years on Flores Island, 800,000 years on Java Island, 700,000 on Luzon Island and at least 118,000 years on Sulawesi Island. Along with these findings, several surface collections which most certainly date back to the Lower Palaeolithic are known, and adds to the diversity of the lithic productions. In this paper, we report what is at stake regarding our current knowledge over the early lithic productions of Island Southeast Asia, without giving more importance to one type of artefact over another. After describing the findings from each islands taken one by one, we compare the similarities and dissimilarities between these sometimes isolated and sometimes connected geographic entities. It appears that each of these islands might have had its own evolutionary trend with its own rhythm.

Keywords: Large Cutting Tools; small simple flakes; Sumatra; Java; Flores; Sulawesi; Luzon; Mindanao

Résumé

L'Asie du Sud-Est insulaire a fait l'objet d'intenses recherches sur sa préhistoire depuis les travaux précurseurs d'Eugène Dubois à la fin du XIX^e siècle. Cela a donné lieu à plusieurs découvertes de productions lithiques très diversifiées d'âge souvent discuté. Des fouilles récentes et anciennes ont permis de confirmer la production d'artefacts en pierre datant d'un million d'années sur l'île de Flores, de 800 000 ans sur l'île de Java, de 700 000 ans sur l'île de Luzon et d'au moins 118 000 ans sur l'île de Sulawesi. Parallèlement à ces découvertes, plusieurs collections de surface datant très certainement du Paléolithique inférieur sont connues, ce qui ajoute à la diversité des productions lithiques. Dans cet article, nous rapportons les éléments de notre connaissance actuelle sur les productions lithiques anciennes de l'Asie du Sud-Est insulaire, sans donner plus d'importance à un type d'artefact plutôt qu'à un autre. Après avoir décrit les résultats obtenus sur chaque île prise une à une, nous comparons les similitudes et les dissemblances entre ces entités géographiques parfois isolées et parfois reliées. Il apparaît que chacune de ces îles a pu avoir sa propre tendance évolutive avec son propre rythme.

Mots clés : Large Cutting Tools ; petits éclats simples ; Sumatra ; Java ; Flores ; Sulawesi ; Luzon ; Mindanao

1. Introduction to the early lithic artefacts of Island Southeast Asia

Most of the Southeast Asian lithic industry terms still in usage nowadays: Pacitanian (Movius Jr, 1944), Cabengian (van Heekeren, 1972) or Cabalwanian (von Koenigswald, 1958), are linked to old discoveries of a few or more stone artefacts out of any context and the significance of which, in terms of traditions, has generally been questioned if not disregarded (Sémah *et al.*, 2014). Choppers, chopping tools, bolas, handaxes on pebbles and large flakes are composing each of these “industries”. Nevertheless, the stone artefacts recovered from a few well-excavated sites highlights the existence in more or less significant proportions of flake tools of small dimensions, somehow mimicking the small tool assemblages of the European Lower Palaeolithic which are currently the centre of many attentions (Rocca *et al.*, 2018).

1.1. Continental *versus* Oceanic islands

In Island Southeast Asia, the search for any cultural tradition has to deal, like for biological questions, with the potential degree of endemism of the findings. These cultural productions may have been, more than anywhere else, the result of periods of isolation possibly leading to some specialization of the lithic products, which were cyclically punctuated by some technical innovations as a consequence of the emergence of land bridges between the islands and the continent (Figure 1). Deciphering these trends is challenging, even more when one has to deal with patchy data.

Island Southeast Asia is a patchy geography that drastically changed over time (Figure 1). While some islands used to be connected to each other during low eustatic periods (such as Java and Sumatra Islands), some others have always been isolated (such as Flores Island or Luzon Island). Furthermore, some islands isolated from the continent have been connected to each other during the past, such as Sumatra and Java islands, or Luzon and Mindoro islands. Additionally, dispersals from one island to another during high eustatic periods has also been proven to have happened (for instance to Flores and to Luzon Islands) during the Lower and Middle Pleistocene without being able at the moment to know about the frequency of such overseas dispersals. Hence, because of such a complexity, it seems reasonable in this synthesis, to consider each island separately at first, before attempting to draw a regional scheme searching for any cultural independence and interdependence in insular Southeast Asia.

1.2. Chronological framework

One can wonder how much these different islands acted as independent worlds or if any panasian tradition could be recognized. Are apparent similarities the result of inheritance, exchanges, or just convergences? This question makes even more sense in light of the discoveries of different contemporaneous humanities on distinct islands (van den Bergh *et al.*, 2016a). But to solve such an issue, it is mandatory to work with a clear chronological framework. Yet, such a framework is still a work in progress in Island Southeast Asia.

Beyond the already mentioned numerous surface findings, the questions over the early lithic productions of the region have been challenged by the difficulties to date some of the sites, especially on the island of Java (see for instance Theunissen *et al.*, 1990 for a historical review). Several reasons can be foreseen for such difficulties but they all relate either to the diversity of the sites to be dated or to the different geochronological methods used, which do not date the same materials and therefore do not focus on the same timing of the site's formation processes (Falguères *et al.*, 2016).

In this paper we will describe any lithic assemblage with an old palaeolithic aspect, whether this consideration has been based on chronology or just typology – which can be misleading. We will systematically mention and detail the findings made during excavations within clear stratigraphic contexts as they obviously do not share the same value as the surface collections. Only the lithic products

recovered from these sites would indeed be able to help us in deciphering the relational properties between core-tools and flake assemblages (Sémah *et al.*, 1992; Moore and Brumm, 2007), and therefore the cultural productions and subsistence strategies of *Homo erectus* and its kin. The region has indeed been profoundly impacted by the debate over the existence of the Movius Line.

1.3. Some historical considerations

The debate mainly focused on the presence or not of handaxes in the East and therefore an Acheulian or Mode 2 technocomplex in Southeast Asia that would be comparable to what was known in the West. According to Movius (1948), the bifacial artefacts recovered in Southeast Asia such as the ones found in the beds of the Javanese Baksoka River, were just an advanced stage of chopping-tools, in line with the manufacture of choppers, and not the product of a specific *Chaîne opératoire*. From this consideration, Movius (1948) drawn a line, since then named Movius Line (Coon, 1962) separating the West with handaxes from the East with chopper and chopping-tools cultures. Although the so-called Movius Line is now broken (Dennell, 2016), one should note that handaxes, although present, are generally rare in East and Southeast Asian lithic assemblages (Moncel *et al.*, 2018; Forestier *et al.* In Review). While Movius (1948) was obviously wrong on the absence of handaxes in the East, he was right on the importance of flake tools in this side of the world as a significant part of Acheulean or Lower Palaeolithic toolkits. Yet, as a reaction to the Movius Line, several Southeast Asian lithic studies since then have paid much attention to pebble-tools (van Heekeren, 1972; Fox, 1978; Soejono, 1982; Bartstra, 1985; Corvinus, 2004; Keates and Bartstra, 2001; Pawlik and Ronquillo, 2003) and specifically to handaxes or protohandaxes, and much less attention to the flake tools. In this paper, we intend to simply report what is at stake regarding our current knowledge over the early lithic productions of Island Southeast Asia, without giving more importance to one type of artefact over another.

2. Java Island

2.1. Pacitanian

2.1.1. A brief history of the research

It took over a century to discover the lithic technology of the Javanese *Homo erectus*, since the seminal discovery of the *Pithecanthropus erectus* at Trinil by E. Dubois (1894). Yet, the search for its industry started as early as the 1930s by G.H.R. von Koenigswald in the frame of the geological and palaeontological survey. It is within the bed of the Baksoka River which flows near the vicinity of Punung, Pacitan Regency, that von Koenigswald (1936) and M.W.F. Tweedie discovered on October 4th 1935 handaxes and large flakes that H.L. (Movius, 1944; 1948) were named Patjitanian (Pacitanian in modern Indonesian). Since then, bifacial technology has focused most of the attention of lithic specialists, sometimes overlooking other lithic productions.

Along the years, more Pacitanian implements have been collected and described by several scholars such as van Heekeren (van Heekeren, 1955, 1972), Houbolt (Houbolt, 1940; Hooijer, 1969), (Bartstra 1978) and others, from the Baksoka River itself or from the same area within terraces of the Serikan, Sunglon, Gedeh and Kiut Rivers. The stratigraphical context and therefore the age of this collection of heavy-duty tools has been much debated since its discovery (von Koenigswald, 1936; Teilhard de Chardin, 1937; Sartono, 1964; Bartstra, 1978; Pope, 2000). The age of the Pacitanian industry is still unknown but could be related, a least partly, to the large flakes and cores recovered in the lowermost sedimentary layers of the nearby cave of Song Terus (Sémah *et al.* 2004; Moncel *et al.* 2018) that has been dated by ESR method to the second half of the Middle Pleistocene (Hameau, 2004).

While von Koenigswald (1936) qualified the Pacitanian as a “Chellean” (which could now partly be synonymised with an early Acheulean period - Moncel *et al.*, 2021) assemblage, Movius (1944; 1948) described it as a Chopper-Chopping tool complex. Movius drew his conclusions on the scarcity of handaxes in the Baksoka River which he compared to other sites in East and Southeast Asia as we mentioned above.

Bartstra (1978) considered the Pacitanian as a local manifestation of the Hoabinhian, this pebble industry known from cave sites of mainland Asia (Colani, 1930). This has been also questioned by Moser (2001) while reinvestigating the Hoabinhian for the whole Southeast Asia, although he did not make any conclusive statements on this specific collection from Java. To date, the most comprehensive review of this large collection disseminated all over the world since Movius (1944; 1948) results from the PhD thesis of Bartstra (1976) and Master thesis of (Bakara, 2007).

2.1.2. Raw material of the Pacitanian

The raw material was mostly composed of silicified limestone and silicified tuff, fossil wood, and, in a lesser proportion, limestone and silicified breccias (Bakara, 2007; Driwantoro et al., 2001). No noticeable difference whatever the type of lithic product was is observable.

2.1.3. Lithic categories and technical characteristics of the Pacitanian

The Pacitanian handaxes were predominantly shaped from silicified tuff and silicified limestone cobbles. Yet, Bakara (2007) identified four handaxes shaped on flakes, evidencing a second reduction sequence strategy. This observation had to be related with the commonality of large flakes found within the Baksoka beds, themselves obtained from large blocks. Pacitanian handaxes are crude whenever compared with European and African ones. Movius (1944; 1948) therefore considered that Pacitanian handaxes were an evolutionary stage of choppers and therefore differed from European and African handaxes. He was followed by van Heekeren (1955; 1972) and Keates and Bartstra (2001) although these latter scholars acknowledged that some pieces were more elaborate and were similar to Western handaxes (Keates and Bartstra, 2001: 27). Bordes (1965: 81) and Simanjuntak, Prasetyo, and Handini (2001) considered for its part the bifacial artefacts from the Baksoka River as true handaxes based on their clear symmetrical shape (Figure 2a-b). Similarly, the presence of true handaxes was not questioned by Bakara (2007). She considered the crude nature of the Pacitanian handaxes as well as their large thickness and the Bose Basin ones were alike. Pacitanian handaxes are all larger than 100 mm. Most of them had an amygdaloid or ovate shape, while a few could be classified as lanceolate.

Although Movius (1944; 1948) noted that handaxes and proto-handaxes (von Koenigswald, 1956: 122) account for about 6% of the Pacitanian assemblage he studied, a re-analysis by Bakara (2007) found they actually account for *ca.* 13% against 15% of choppers and chopping-tools and *ca.* 44% of flakes. The part of handaxes in the Pacitanian is relatively important compared to other Southeast Asian localities such as the Bose Basin in Southern China, also famous for its handaxes but within which bifacial pieces only account for less than 3% of the lithic products (Moncel et al., 2018, 66).

Like for the handaxes, Bakara (2007) identified two chaînes opératoires for the choppers and chopping-tools. 60% of these artefacts were obtained through débitage of large flakes, while 40% were directly shaped from nodules (20%) and cobbles (20%) blanks.

A total of 23 picks were reported by Bakara (2007). They were mainly shaped from nodule blanks although a few were produced from large flakes or shaped from cobbles. These picks should be put in relation with the old “flat-iron” lithic terminology used by van Heekeren (1955; 1972) which used to refer to flat and large proximal extremity artefacts, and were considered as typical of the Pacitanian Industry.

Movius (1944: 91), as further reported by Mulvaney (1970), noticed that the majority of the assemblage is composed of flakes, a part of which was used as cores. Some of the smallest cores are smaller than 50 mm suggesting similarly small flakes. Yet, only 16 flakes (8%) were smaller than 50 mm. Butts of the Pacitanian flakes are mostly faceted but also cortical (for the larger flakes) and plain (Bakara, 2007). Large and smaller flakes had some retouches which, for the latter category, could result in scrapers. Blanks were mainly nodules and cobbles and exploited through discoid and semi-prismatic techniques.

Retouches were common (*ca.* 75%) on the Pacitanian large flakes, but most of them (75%) were irregular and could be the result of use or, more probably, taphonomic conditions. Whenever organized, retouches were mainly aimed at producing scrapers of different types: side scraper, end scraper and double scraper. Less than ten denticulates were also counted.

2.2. Sangiran flakes

2.2.1. A brief history of the research

Discovered during an excavation on top of one of the hills near Ngebung vicinity in the Sangiran dome by von Koenigswald in June 1934, just before his discovery of the Pacitan stone artefacts (Teilhard de Chardin, 2004 January 20, 1935 letter; Movius Jr 1944, 19:354 footnote 12), the 123 Sangiran flakes have been first very briefly reported by van Stein Callenfells (1936), figured at several occasions by von Koenigswald (1937, 31 fig. 14; 1939, 42 fig. 3) and by van Heekeren (1972, 61:50 fig. 14), but only described in 1973 by von Koenigswald and Gosh (1973). This long time took by G.H.R. von Koenigswald to properly publish the Sangiran flakes was partly due to the impressive number of archaeological and palaeontological discoveries he made and that occupied him intensively apart of his field activities, but also because he was much influenced by the seriation of the Palaeolithic that H. Breuil was building at that time from the Somme River Valley in France, and he therefore gave more credits to the Pacitanian LCTs he compared to the “Chellean”. Also in question was the absolute age of these artefacts he excavated in June 1934. Indeed, subsequent to the first mention by van Stein Callenfells, 1936) of these artefacts, the origin of the Sangiran flakes have been much disputed, (Movius, 1944, 19:354) reporting they were from the “recent” volcanic Notopuro beds, to which van Heekeren 1972, 61:48) and later Bartstra (1974; 1978; 1985) concurred based on its geological re-inspections of the fossiliferous sites. Von Koenigswald changed his views (von Koenigswald and Ghosh, 1973) and became convinced these Sangiran tools were the products of *Homo erectus*. Simanjuntak and Sémah (1996) also reinvestigated the Ngebung hills and recovered a few stone artefacts, confirming the high antiquity of at least some of these artefacts.

Teilhard de Chardin (1938, 1937) and Movius also collected small chalcedony and jasper flakes while visiting Sangiran in 1938 (van Heekeren, 1972, p. 48). Van Heekeren (1972) further collected between 1953 and 1968, 70 small (between 2 and 6 cm) flakes made out of the same material.

Sartono (1980) and Bartstra (1985; 1989), in agreement with van Heekeren (1972, p. 49) would consider the Sangiran flakes to be Upper Pleistocene in age and tend to associate them to the more recent group of Javanese *Homo erectus*, the ones represented by fossils from Ngandong, Sambungmacan and Ngawi and sometimes referred to as *Homo soloensis* (Oppenoorth, 1932; Zeitoun, 2002), and even referred to them as Ngandongian implements.

In many ways, the Javanese lithic record is mimicking the European one. For the longest time, the LCTs attracted much of the attention and, similarly, von Koenigswald and his colleagues attached most of the importance to the Pacitanian implements. Yet, small (less than 5cm) unretouched flakes were retrieved in several European sites contemporaneous to sites with handaxes.

2.2.2. The excavation of Ngebung 2 hill

The bottom of the Ngebung 2 hill has been excavated yearly by a French-Indonesian team between 1989 and 1994 and was dated by several physico-chemical methods to *ca.* 800 ka (Falguères et al., 2016). The Sangiran flakes were rare, only a handful were retrieved along with a collection of large cutting tools (LCTs). Simanjuntak and Semah (1996) reported 20 Sangiran flakes from every stratigraphical ensemble of the site, including from the lowermost unit which has been interpreted as an occupation floor (Brasseur, 2009; Sémah, 2001). They yet considered that at least part of these small anthropogenic flakes was naturally present at the site as part of the sedimentary matrix and therefore estimated their age to be older than the heavy-duty tools. Six of the Sangiran flakes presented clear retouches. Also from Ensemble A, Simanjuntak and Semah (1996) reported the occurrence of two cores.

The Large implements included some bolas, polyhedrons, choppers, cleavers and horsehoofs made out of andesite (Figure 3a,f). Worth to be noted at Ngebung was the discovery of a cleaver struck and shaped on a *Stegodon* tusk (Figure 3g). This assemblage of LCTs which were recovered along with several animal bones with clear butchery marks, somehow recalls the Pacitanian artefacts.

2.2.3. Raw material of the Sangiran flakes

Sangiran flakes were mainly made on chalcedony or, more rarely, on tuff, jasper and silicified limestone (Bartstra, 1985; Simanjuntak and Semah, 1996). One has to consider that good quality raw materials are missing in the Sangiran area. The only good quality material is the one transported as small dimension pebbles within the rivers flowing over the dome. The larger implements found along with the Sangiran flakes at Ngebung 2 were made on local andesite (Brasseur, 2009) and metamorphic rocks and quartz (Soejono, 1982) that were exogenous to Sangiran area.

2.2.4. Lithic categories and technical characteristics of the Sangiran flakes

Although some of the Sangiran flakes were clearly dating back to the early Middle Pleistocene at least, it remains unknown for how long these simple artefacts have been produced. Therefore, although the 727 pieces described by von Koenigswald and Ghosh (1973) were apparently homogeneous and similar to what was further found in the excavation of Ngebungs 2 through 20 pieces, it is unclear whether they represented a single assemblage or not.

Sangiran flakes were characterized by their small dimensions (rarely larger than 5 cm), single striking platform with a wide knapping angle and a clear bulb from which the use of hard hammerstone could be deduced. Cores were rare and poorly organized (Bartstra, 1985; van Heekeren, 1972; Simanjuntak and Semah, 1996) (Figure 3a-c).

Sangiran flakes have mostly short and narrow striking platforms. Unlike in the flakes from the Baksoka River, butts of the Sangiran flakes are cortical, which may be related to the small dimensions of the blanks. Half of the material had a remaining cortex according to von Koenigswald and Ghosh (1973).

Retouches were common and a tentative typology of these Sangiran flakes was proposed by (van Heekeren, 1972; von Koenigswald, 1936; von Koenigswald and Ghosh, 1973). While noticing the poor manufacture of the Sangiran flakes, von Koenigswald (1936) and later van Heekeren (1972) already attempted to recognize some types among which they listed: trapezoidal flakes, pointed flakes, different types of scrapers, notches and borers. Yet, although the Sangiran flakes did possess some retouches (Figure 4), identifying types was, at most, only tentative.

What have been termed Sangiran flakes not only account for flakes but also for blades. Indeed, although none of the authors ever produced any detailed metrical data for the Sangiran flakes, all of them describe the presence of blades, meaning flakes twice as long as wide, but nothing like a blade débitage. Three of these blades were recovered at Ngebung 2. Blades seem to have been quite common as they accounted for 15% and 24% of the recovered artefacts (Simanjuntak and Semah, 1996; von Koenigswald and Ghosh, 1973). Yet, most of the flakes were short and broad with a prominent bulb (von Koenigswald and Ghosh, 1973), although all of the flakes from Ngebung 2 excavation had a flat bulb (Simanjuntak and Semah, 1996, p. 25). Flakes and blades were part of the same knapping methods and reduction strategies.

Large flakes were rare. Von Koenigswald and Ghosh (1973) mentioned 22 artefacts out of 727 pieces that are larger than 5 cm. As a matter of comparison, only 8% of the Pacitanian flakes from the Baksoka River are smaller than 5 cm. But this has obviously to do with the competence of the rivers and streams which have naturally sorted these assemblages, or at least the raw material, out by size (Simanjuntak and Semah, 1996).

2.2.5. The age of the Sangiran flakes

Based on Ngebung 2 excavation results, the Sangiran flakes might be older if not the same age as the Javanese LCTs. Widiyanto et al. (2001) have reported even older flakes excavated from the Sangiran dome coming from the excavation of the Grenzbank calcareous conglomerate underlying the Kabuh series, and even potentially from the even lower Pucangan layers (Widiyanto et al., 2008) near the vicinities of Ngledok and Dayu. These flakes were made from the same material as the Sangiran flakes. A full description of these artefacts is yet still missing.

Between 1987 and 1988, rescue archaeology was conducted during the construction of Kedung Ombo dam, near Miri vicinity about 10 km north of Sangiran (van Es, 1931), at two localities along Kaliuter River, Kedung Cempleng and Pancuran (Djubiantono, 1992; Sémah et al., 1996). At Kedung

Cumpleng, several fluviually reworked flakes and chopping tools along with faunal remains including *Stegodon*, *Rhinoceros*, Cervidae, crocodile and tortoise dating back to about 0.9 Ma, so potentially older than the archaeological layers of Ngebung 2, were retrieved from a clayey sedimentary unit. The artefacts were primarily made in limestone.

The problem posed by these small simple flakes is their unspecific aspect that cannot be solely related to any chronological cultural period unlike more sophisticated stone artefacts would be. These small simple flakes can indeed be found at any place. Widiyanto and Noerwidi (2020) for instance collected some small chalcedony flakes from within the Gintung River near Bumiayu, a place further known for its archaic faunal remains evidencing the potentially earliest colonization of Java. As it stands, they question the potential continuous production of this type of lithic products by all the types of *Homo erectus* that ever lived in Java, starting with the archaic robust forms once named *Meganthropus*. Yet, unless they are found within a clear stratigraphic context, these flakes remain poorly informative.

The perduration of these flakes is also in question. The recent discovery near Ngandong along the Solo River of an *in situ* lithic assemblage is somehow reviving the debate over what group of *Homo erectus* would have produced the Sangiran flakes. Small (< 5 cm) and unspecific flakes, apparently similar to the Sangiran flakes have indeed been found during the excavation of several localities near Matar vicinity (Fauzi *et al.*, 2016) within two terraces of the Solo River, potentially correlated to the one that has delivered the Ngandong late *Homo erectus* remains which have been recently dated to between 117 000 and 108 000 years ago (Rizal *et al.*, 2020). These flakes accounting for 89% of the lithic assemblage were recovered along with bolas and polyhedrons comparable to the ones further recovered at Sangiran and in excavation at Ngebung 2, within a layer containing a diverse fauna such as *Stegodon trigonocephalus*, *Bubalus palaeokarabau*, *Bibos palaeosondaicus*, and *Hexaprotodon sivalensis*. These small flakes were made partly from chalcedony, partly from chert and, to a lesser extent, from jasper.

3. Sumatra Island

3.1. History of the research

It is at Sumatra that Eugène Dubois first landed in Indonesia (Albers and Vos, 2010) before transferring to Java which had resulted in the discovery of the *Homo erectus* fossils at Trinil site. If the Paleolithic prehistory in Indonesia has long remained focused on Java, it is because of the numerous paleoanthropological discoveries in Central Java which have become world-famous with the *Pithecanthropus* remains. This explains why most of the researchers have concentrated their efforts on this small island rich in human fossils as G.H.R. von Koenigswald, H.R. van Heekeren, R.P. Soejono or G. J. Bartstra.

From an archaeological viewpoint, compared to Java, Sumatra has been forgotten and has yielded far less information than its southern counterpart to which it has been repeatedly connected during low eustatic periods. Sumatra did not immediately enter the debate over the existence of an *Acheulian facies in Indonesia*, because of its lack of archaeological evidence and of major scientific operations in the field. Sumatra's natural wilderness and dense rainforest may partly explain this: the forested environment is very dense, difficult to access with incessant equatorial rains. Yet, with its almost 500,000 km² this island offers a privileged access to the first settlements from the mainland Southeast Asia which left traces of their migration with stone artefacts as early as *Homo erectus* arrived in Indonesia.

The renewed interest for Sumatra Island started between 2000 and 2004, when a Franco-Indonesian team launched field research in the southern Sumatra near the foothills of the large central volcanic chain. There, an unknown and ancient lithic assemblage was discovered in the province of Ogan (Kabupaten Ogan Komering Ulu-OKU) near the town of Baturaja (Forestier, 2007; Forestier *et al.*, 2006, 2005). Several field surveys led to surface collections in the Air Tawar and Air Semuhon Rivers, two tributaries of the Ogan River located near the village of Pondok Selabe in the Padangbindu karstic area. This karst has been a refuge area at all times and was also used as a rockshelter by many groups during the Holocene period with Neolithic groups and the last Hoabinhian hunter-gatherers (Forestier *et al.*, 2017).

3.2. The raw material of the Ogan River artefacts

Most of the pieces were made on local chert collected from the river bed or silicified breccia, basalt, andesite, red jasper, silicified wood, siliceous limestone or quartz. The great diversity of raw materials and the different morphologies of the materials used, whether on block, sheet or large pebble, were one of the particularities of the paleolithic sumatran knappers, who obviously settled near the raw material deposit along the rivers.

3.3. Lithic categories and technical characteristics of the Ogan River artefacts

The stone artefacts discovered at Padangbindu in the riverbeds and on the terraces look like «archaic» facies reminiscent of the Pacitanian in Eastern Java with numerous handaxes, cleaver, cores and choppers. These Acheulian facies has been evidenced in Sumatra by more than a hundred of pieces evidencing this Large cutting tool diversity.

Although discovered out of any stratigraphic context, the surface Padangbindu lithic assemblage presents the only reference stone corpus for the ancient Palaeolithic period in Sumatra island. It seemed reasonable, like for the Javanese Pacitanian, to regard this toolkit as the potential technical culture of *Homo erectus*. Such an attribution to *Homo erectus* was made on a typological and technological analysis basis, but also from a morphometric point of view, as these massive pieces did not look like anything produced by *Homo sapiens* in Southeast Asia or elsewhere.

The diversity of very large and heavy-duty tools appeared to be much greater in number and morpho-types than those from the Baksoka River in Eastern Java (Bartstra et al., 1976; Sémah et al., 1992). More generally these Sumatran artefacts referred to what we know elsewhere in East Asia (specifically in Southern China) or continental Southeast Asia (Moncel et al., 2018).

The Southern Sumatran Lower Palaeolithic assemblage exhibited classic LCTs known from a large number of Acheulean assemblages around the world. These LCTs were retouched in denticulated, clactonian notch or scraper (convergent or lateral). There were also several choppers (lateral and distal cutting), chopping-tools, thick-fronted *rabot* and horse-hoofs (Figure 3b-e).

The Padangbindu assemblage further included some exceptional pieces such as prismatic cores weighing several tens of kilograms with a single striking platform from which LCTs were detached by direct percussion with hard hammerstones.

The originality of this Sumatran lithic facies lay in the size and massiveness of several pieces, especially the LCTs and more particularly the handaxes (Figure 2e-f). Several very large pieces (more than 20 cm and more than 3kg) such as handaxes were common within this Southern Sumatran assemblage. These handaxes were very heavy, long and thick, and were made from fine grained chert massive blocks, but also, more rarely, from LCTs which gave some more bifacial pieces, or even from flakes with partial bifacial retouch, one could tentatively interpret as a preform. These pieces could sometimes reach more than 25 cm in length for the largest ones and evidence a relatively well mastered shaping process, even if the shaping operating sequence was relatively short. A preforming stage was carried out by direct percussion with only three to four generations of removals. This explained the limited standardization in the assemblage.

However, in South-East and East Asia, handaxes are generally poorly shaped and rarely finished products (e.g. remaining cortex) and modestly crafted. In that sense, Sumatra is a classic example, but of very large size shaping products.

These very massive pieces were often very difficult to classify from a typological point of view other than “macro-tool” category with variable morphologies close to the initial and natural morphology found in the environment (e.g. affordance) and with a relatively imperfect bifacial balance plan (Figure 2e-f). The transverse sections of the bifaces were very thick and trapezoidal and rarely biconvex or biplane/convex as is the case for the more classical bifacial productions known in the Acheulean, for which the technical degrees are obviously more advanced with a change of technique (hard/soft hard - hard/soft hammer), structurally hierarchical according to several successive stages of shaping. The short shaping sequences with minimally invasive removals, as found on Sumatran bifaces, explained the importance of residual cortical areas, particularly in the mesial and proximal parts.

The shaping flakes had the following characteristics: thick, wider than long, unprepared striking platform often cortical or semi-cortical, highly arched profile, cortical upper surface with preferentially unidirectional anterior removals.

Also noticeable were some typical cleavers made in chert and some undetermined mega-tools made on massive blocks (more than 7 kg) with multiple techno-functional units.

Thus, the Sumatran palaeolithic tool kit demonstrated a new and very complete lithic assemblage where the handaxes were well represented among the other artefacts. These handaxes also provided new information about the technical particularities of manufacture as well as the *lato sensu* definition of the “biface” in insular Southeast Asia. Often considered as “atypical” or unorthodox compared to others, they belong above all to a tropical environment with a technical way of doing tools needed: a diversity resulting from an adaptation and a tropism. The main difference between Sumatra heavy-duty tools and Java is certainly the notable absence of bolas.

4. Flores Island

4.1. History of the research

After some fossils of the large sized *Stegodon florensis* discovered in December 1956 near the vicinity of Boawae were reported to the Dutch Father Theodor Verhoeven, the first excavations on Flores Island were organized in March 1957 by this latter which led to the discovery on surface of some stone artefacts at a site named Ola Bula (Hartono, 1961; Maringer and Verhoeven, 1970; Verhoeven, 1958). More stone artefacts, pebble-tools and retouched flakes, were discovered along the years since the summer of 1963 and until the 1970 during excavations in Mengeruda area about ten kilometers on the west of Ola Bula, still in the Soa Basin, along one of the tributaries of the Ae Sissa River (Maringer and Verhoeven, 1970) several archaeological localities were identified in the Mengeruda area, including Mata Menge where more artefacts were discovered (Maringer and Verhoeven, 1970; Verhoeven, 1958). Although these artefacts were believed to be contemporaneous to the *Stegodon* beds by some (Maringer and Verhoeven, 1970; van Heteren and de Vos, 2012; von Koenigswald and Ghosh, 1973), their original association as well as their actual anthropogenic nature was contested by others (Allen, 1991; Bartstra and Basoeki, 1989).

4.2. The Wolo Sege and Mata Menge excavations

This seminal work motivated a Dutch-Indonesian team to reinvestigate the Soa Basin (van Heteren and de Vos, 2012) which led to another excavation at Mata Menge in April-May 1994 resulting in the discovery of fourteen stone artefacts (Morwood et al., 1997). After this report, repeated excavations took place at Mata Menge as well as at the nearby locality of Boa Lesa by an Indonesian-Australian team between 2004 and 2006, and again since 2010. The Mata Menge excavation resulted in the recovery of more than a thousand of artefacts (Brumm et al., 2016) dated to between 880 and 800 +/- 70 ka, and of a Hominin jawbone associated with similar stone artefacts in 2016 but originating from a younger layer dated to about 700 ka (Brumm et al., 2016). Additional work by the same team has been done 500 m east of Mata Menge and north of Boa Lesa at the site of Wolo Sege, within the tuffaceous deposit at the base of the Ola Bula Formation which has been dated to 1.02 +/- 0.02 Ma. This excavation led to the discovery of 45 stone artefacts which are so far the oldest artefacts from Flores Island (Brumm et al., 2010a). The authors note no major differences between the Soa Basin artefacts (Wolo Sege, Mata Menge and Boa Lesa sites) whatever the locality and age are (Brumm et al., 2010a, 2006).

4.3. Raw material of the Soa Basin artefacts

The raw material was mainly composed of locally available volcanic rocks (Brumm et al., 2006; Moore and Brumm, 2007), meaning andesite (Maringer and Verhoeven, 1970) and basalt (Morwood et al., 1997). Occasionally some artefacts were made in fine-grained chert, chalcedony, quartzite, silcrete, porphyry, chlorite, opal which were collected outside the Soa Basin. It has been suggested that large cobbles were reduced outside the site before transport (Moore and Brumm, 2007).

4.4. Lithic categories and technical characteristics of the Soa Basin artefacts

The Soa Basin artefacts were mainly small (less than 5 cm) flakes (Figure 3d-f). Although Maringer and Verhoeven (1970, p. 238) mention the presence of what they call a bola, the picture they provide (Maringer and Verhoeven, 1970, p. 242) is not convincing and definitely differs from what is known on Java Island. The flakes were obtained both from small cobbles and large flake blanks, mainly through centripetal discoid (radial) reduction, mostly bifacially (Brumm *et al.*, 2006). A few multiplatform cores were also identified (Moore and Brumm, 2007). The use of bipolar percussion on anvil has been suspected along with freehand percussion and burination (Brumm *et al.*, 2010b; Moore *et al.*, 2009). Permutation from one technique to another has been observed. Reduction sequences were mostly short with a mean of less than 6 removals per core, depending on the type of core. Some of the core with full reduction sequence were sometimes reutilized as tools or core tools (Moore and Brumm, 2007). Knapping platforms were mainly single faceted (40%) and unprepared with a remaining cortex (*ca.* 30%). Reduction strategy was mainly short (mean of six removals but maximum of 26). Retouches were rare (9%), made with hard hammerstones, and mainly dedicated to resharpening the edges. Only five flakes seemed to have been retouched to shape a pointed tip. These retouched tools were limited to the larger flakes, probably obtained from cobbles not recovered at the sites, unlike the unretouched artefacts that were obtained from pebble cores discarded where the excavations took place (Moore and Brumm, 2007).

5. Sulawesi Island

5.1. History of the research

In 1949, van Heekeren reported on the discovery made in 1947 near Beru and Cabenge on the surface of an alluvial nappe of the Walanae River in the Southwestern leg of Sulawesi, 67 stone artefacts he very briefly described as similar to the Javanese Sangiran flakes. These were said to have been found along with the archaic fauna of the island. Additional fieldwork in the same area was made by van Heekeren (1972) between June and August 1970 (Bartstra *et al.*, 1992). Subsequent work by a Dutch-Indonesian team in the 1980's yet questioned the penecontemporaneity of the fossils and the artefacts (Bartstra *et al.*, 1992). More surface findings of artefacts within several localities of the Walanae River terraces were made during this period as well as between 1990 and 1992 (Bartstra *et al.*, 1992). Among these was a core-tool assemblage (Keates and Bartstra, 2001). The core-tools and flakes have been coined as Cabengian Industry although its integrity and age were unclear. It is only in 2016 that the first stone artefacts were found embedded with an archaic fauna in Sulawesi during excavations at the site of Talepu which has been dated to at least 118 ka (van den Bergh *et al.*, 2016b).

5.2. Raw material of the Cabengian artefacts

The Cabengian artefacts recovered from the gravelsheet of the Walanae River were mainly made in silicified limestone and silicified tuff, selected from river cobbles (Keates and Bartstra, 2001).

5.3. Characteristics of the Cabengian artefacts

Keates and Bartstra (2001) mentioned the occurrence of a few bifacially modified cobbles along with some uniaxially modified cobbles within the collection they made on the surface of the Walanae alluvial nappes. The aim of the reduction sequence producing these tools was to create a sinuous cutting edge through successive alternating removals. A few handaxes were also recovered from the Walanae Valley surface collections. Yet, Keates and Bartstra (2001), just like (Movius, 1948) before them about the Pacitanian, considered these bifacial artefacts from the Cabengian as conceptually distinct from Acheulean handaxes and referred to them as pointed bifaces, although the reasons for this distinction are not clear as they further mentioned the presence of a symmetry similar to Acheulean handaxes. These pointed bifaces had for the vast majority of them a remaining cortex and a sinuous edge. This suggests, as for the Pacitanian core-tools in the view of (Movius, 1948), that bifacial cores and pointed bifaces in

Cabenge were part of the same shaping process, aiming at reducing the thickness of the edges. Cabengian heavy duty-tools cluster with the smallest of the Pacitanian ones. Description by Keates and Bartstra (2001) of several artefact categories, from bifacially modified cobbles to pointed partial biface til pointed bifaces, could represent either several stages of this reduction sequence that would be available in the collections made along the river, or a different stage of final production related to the quality of the raw material. Keates and Bartstra (2001) indeed noted that the poor quality of the raw material which might have limited the finalization in the shaping of some of the Cabengian artefacts.

Cores were all the three, single platform, double platforms and multiple platforms. A few horse-hoof cores have also been recovered. Most of the cores had a remaining 30 to 50% cortex. Considering the number of flake scars, it is believed that the reduction sequences were short (maximum 18 scars). Flakes were removed concentrically or all around the periphery of the cores.

Cabengian flakes were medium to large size (more than 5 cm). Striking platforms were diverse, from cortical, to plain and faceted. Most of the flakes were amorphous and cortical with rare retouches. Whenever present, retouches were localized on one of the edges as resharpening, and, in one case, to produce a notch.

5.4. The excavation of the Talepu site

The site of Talepu is located 600 m west of the Walanae Valley. Two trenches were excavated between 2007 and 2012. In the first trench, 318 stone artefacts were recovered (Figure 4h) along with *Bubalus depressicornis* within a high-energy fluvial gravelsheet. In the second trench, three flakes (Figure 4g) were recovered along with *Celebochoerus heekereni* from a clayey-silt layer. Almost one-fourth of the assemblage comprised cores, some of which were reduced through centripetal discoid (radial) strategy to remove flakes. The flakes were small (less than 5 cm) to large size dimensions (van den Bergh et al., 2016b). It is still unclear whether these artefacts resemble the ones reported by (van Heekeren, 1972). They yet differ from the bifacially shaped cobbles of the so-called Cabengian industry described by Keates and Bartstra (2001).

6. The Philippine Islands

6.1. History of the research

Following the Pacific Science Congress in Bangkok in November 1957, von Koenigswald visited the Philippines for the second time on the invitation of the anthropologist and archaeologist H.O. Beyer and, together with Laurence L. Wilson, best man of Beyer, he conducted two field surveys in the Cagayan Valley along the Cabalwan anticline from December, 1957 to January, 1958 (Ingicco and Reyes, In press). They found several pebble tools which von Koenigswald (1958) described as the Cabalwanian industry.

Following this report, systematic field surveys and large-scale excavation of three sites were conducted in the Cagayan Valley by the National Museum of the Philippines in the area between August-September 1971 and April-May 1972. Jesus Peralta and Robert B. Fox took the lead of this field research. At Espinosa Ranch loc. 4, two few stone artefacts were recovered 1.83 m below the surface. In a deeper mudstone layer, several elephant bones were further recovered. The penecontemporaneity of the artefacts and the fauna could therefore not be demonstrated back then.

In 1995, while bulldozing his farmland near the village of Rio Chico (Nueva Ecija Province, Luzon Island), an owner found two stone artefacts, a bifacially worked chert and a pebble-tool (Pawlik, 2004). This led to excavations at the site named Arubo 1 after joint surveys by the University of the Philippines Diliman and the National Museum in 2001 (Pawlik, 2002). Yet, because of the heavy disturbance the area underwent, the antiquity of the findings could not be demonstrated beyond the typology of the artefacts.

From April 26 to May 10, 2001, a Dutch-Filippino team headed by Angel Bautista from the National Museum and John de Vos from Leiden Biodiversity Center relaunched the research in the Cagayan Valley along the Cabalwan anticline which led to the excavation of the so-called Espinosa Tusk Site. The fossils and the stone tools were found near the surface, in the topsoil and therefore the primary association of the two was not clearly established.

In October-November 2004, researchers and students from the Archaeological Studies Program of the University of the Philippines conducted surveys near Cagayan de Oro City in northern Mindanao Island and an excavation at the Huluga Open Site (Neri et al., 2004; Neri, 2006). The area was already known for its pebble-tools since the work conducted in 1992 by A. Bautista from the National Museum.

Worth to be noted was the serendipitous discovery of a handaxe by Prof. Victor J. Paz in 2006 (as reported and illustrated by Dizon and Pawlik, 2010) along the Ille limestone tower in the Devil Valley (Figure 2d). This artefact made in a dense dolomite rock has no relation with the archaeological material excavated in the nearby site of Ille Rockshelter by the teams of the Archaeological Studies Program of the University of the Philippines under the direction of V.J. Paz and H. Lewis and which dates to the Terminal Pleistocene.

In 2014, we rejuvenated the Cagayan Valley research, surveying the area and conducting excavations at the Kalinga site since then on a yearly basis.

6.2. Kalinga and the Cagayan Valley (northern Luzon)

An almost complete skeleton of a rhino (*Nesorhinus philippensis*) (Antoine et al., 2021) was recently discovered and excavated at the Kalinga site within a 709 ± 68 ka old sedimentary layer. Associated were less than a hundred of crude stone artefacts used to slaughter the carcass (Ingicco et al., 2018). This assemblage was composed of stone flakes, lithic cores, and hammerstones. The technological features of these artefacts suggest the use of two different reduction strategies, namely bipolar percussion on anvil and freehand percussion. Both methods were used independently one from the other, depending on the type of cobble the Kalinga toolmakers had at hand. The knapping products were mostly of small, less than 5 cm dimensions and retouches were rare (Figure 4i-e). At Kalinga, such small tools are the direct consequence of the small dimensions of the cobbles available in the surrounding environment. The raw material is diverse for such a small assemblage, with fine-grained chert, coarse-grained chert, jasper, quartz, dacite. The cobbles found in the alluvial nappes in the vicinity of the Kalinga site are very diverse in terms of rock type, however, most of them, whatever the material is, of poor quality for knapping purposes. Although the few Kalinga artefacts were small and simple, they were most certainly very efficient for butchering most of the rhino carcass (Ingicco et al., 2020). The so-called Cabalwanian chopper and chopping tools described by von Koenigswald (1958) were not retrieved at Kalinga site and could not be related in any manner to the artefacts we excavated.

6.3. Arubo 1 (eastern Luzon)

Arubo lies on chert boulders and this rock was certainly the primary source for the raw material. All the artefacts were made in chert, although different types of chert were identified (Pawlik, 2002). The excavation of Arubo 1 led to the discovery of three artefacts embedded just above the sandstone bedrock but only a few centimeters below the bulldozed surface. Most of the artefacts were collected from the surface. The assemblage was composed of 18 artefacts and included bifacial tools like a proto-handaxe and a cleaver, as well as unifacially modified artefacts (Pawlik, 2002). One face of the 150 mm long proto-handaxe (Figure 2c) was almost fully modified, while more cortex remained on the other face. The proto-handaxe remains relatively thick with a maximum thickness of 98 mm. The shaping seemed to have taken place at different stages since several shades and colorations of patina were observed (Pawlik, 2002).

Five cores were found in Arubo including a core on a large flake in which the ventral face was used as striking platform, a core with circular reduction, and a core with a morphology reminiscent of horse-hoof cores.

Several simple choppers and chopping-tools were found at Arubo. One was a unifacially dorsal retouched flake with a partial retouch of its ventral face. Due to the proximal truncation and the centripetal orientation of its dorsal negatives, a resemblance with Levallois flakes was noted (Pawlik, 2004, 2002).

A large, thick flake was made of a large chert boulder of which the end was carefully modified into a thin and narrow spatula-shaped tip, a trapezoidal scraper, and an elongated, morphologically clearly blade-like flake (Pawlik, 2002).

6.4. Hulaga Open Site (Mindanao Island)

Four choppers and one chopping-tool were recovered on the surface from Hulaga Open Site (Neri *et al.*, 2004). It is believed these artefacts were eroding from the Bukidnon Plateau at the foot of which the site was located. Thirteen additional choppers and chopping-tools from the same locality were reported by (Tiauzon *et al.*, 2020). Two other pebble-tools were also described from surface findings at Laque locality at the other side of the Bukidnon Plateau. The pebble-tools were made in andesite, limestone and chert (Bautista, 1992). The cobbles were knapped with hard hammerstone by freehand with an angle of 75°. Six to thirteen removals were made to produce these choppers and chopping-tools (Tiauzon *et al.*, 2020).

7. A synthesis to the early lithic artefacts of Island Southeast Asia

Before all, one must make the distinction between the lithic assemblages recovered within secured archaeological excavations from the ones discovered on the surface. Indeed, although the latter stone artefacts described here have a clear old Palaeolithic aspect, only the former can provide information on the integrity of the collections and can be dated.

A part from Sumatra, each of the six Southeast Asian islands reported here have delivered some old Palaeolithic artefacts from at least one securely excavated site. Three of them, Ngebung 2 on Java, Mata Menge on Flores and Kalinga on Luzon are about the same age, dating back to the Lower-Middle Pleistocene transition and could therefore be tentatively compared. One, Talepu on Sulawesi, is significantly younger, dating back to MIS 6 or 5e.

Ngebung 2 and Kalinga recorded occupation floors that could be interestingly compared one to the other. Kalinga was more specifically dedicated to the butchery of a single large-size carcass (Ingicco *et al.*, 2020). In contrast, no butchery activities were evidenced at Mata Menge and no refittings were found (Brumm *et al.*, 2010b). Conversely, Mata Menge delivered the richest lithic assemblage for the Lower Palaeolithic of Island Southeast Asia, while lithic artefacts are scarce at every other excavated sites.

7.1. Can we recognize any traditions or were these islands independent worlds?

Von Koenigswald and Ghosh (1973, p. 2) considered the Sangiran flakes they found and the flakes recovered from the Middle Pleistocene Ola Bula Formation of Flores Island's Soa Basin discovered by Maringer and Verhoeven (1970) as identical (see also van Heteren and de Vos, 2012). One should first mention the difficulties and risks in comparing such simple and somehow unspecific artefacts. Yet, some similar strategies were present in the different localities, notably the provenance of the raw material which was always collected in the nearby environment, whatever the quality of the blanks was, resulting sometimes in a large diversity of rock types. This is true in Kalinga and probably in Wolo Sege and Mata Menge, as well as in Ngebung 2, although in this latter case, this has been noted for the LCTs (Sémah *et al.*, 1992); but it was also probably the case for the Sangiran flakes as well, for which the small size (less than 5 cm) like in the other sites was probably the result of the small dimensions of the cobbles in the collection area.

Whenever larger cobbles were available, it seems that larger implements were produced. This is obvious in Sumatra and seems to be true at Talepu in Indonesia as well as in the Pacitanian collection from the Baksoka River which both count larger flakes (Figure 5). Yet, one should remember that Talepu artefacts were, in one of the two excavation trenches, recovered from a high-competence alluvial bed (van den Bergh *et al.*, 2016b). Therefore, one cannot exclude that these large flakes were naturally sorted out from the smaller artefacts by the competence of the water flow. It therefore seems too far-fetched at present to draw any conclusive remarks regarding the presence or absence of large and small flakes at the different localities. Yet, we can note that in Kalinga, the scarcity of large flakes is original (Ingicco *et al.*, 2020).

It seems clear that there are some important differences between the different islands, notably regarding the importance of retouches. Although von Koenigswald and Ghosh (1973) were certainly ambitious in building a typology for the Sangiran flakes, their enterprise rightfully pointed to the importance of retouches of the Sangiran flakes. Retouches are indeed very frequent on the Javanese

small flakes recovered at Ngebung 2 and on the surface, while they are only anecdotal on the Soa Basin artefacts as well as on the Kalinga flakes. There was obviously an intentionality in the Javanese toolmakers' minds that was not present on the other islands. The rarity of retouches at Kalinga for instance, did not prevent the Hominins to successfully deflesh the carcass of a large game. Although retouching activities would not have added much more time to the production sequence, even more on such small artefacts, the chaîne opératoire seemed to have been different and quite straightforward on both, Luzon and Flores Islands. This points to the importance of shaping activities on Java, which could, somehow, be related also to the presence of LCTs, which are absent from the Soa Basin and from the Cagayan Valley, but not from Luzon Island as a whole. To sum up, the concept of shaping is almost absent at Mata Menge, Kalinga and Talepu. There are no LCTs and retouches are very rare. The chaîne opératoire was almost exclusively oriented towards the débitage.

7.2. Heavy-duty tools and small flakes

The parallelism between the LCTs from Ngebung 2 and the Pacitanian of the Baksoka River has never been really investigated. According to (Keates and Bartstra, 2001, p. 23), there are no reasons to group the Baksoka River artefacts and the Walanae River artefacts into two different traditions.

Although handaxes and other heavy-duty tools attracted most of the attentions and fuelled a long run debate among scholars, one should note that flakes account for the vast majority of the assemblages (73% in van Heekeren, 1972; 58% in Movius, 1948), just as they do for other purportedly contemporaneous assemblages on continental Asia such as in Bose Basin localities for instance (Forestier, In review). In contrast, handaxes account for a small proportion of the assemblage (7% in van Heekeren, 1972, p. 35; 14% in Movius, 1948). Interestingly, all the excavated sites but Ngebung 2 miss LCTs or core-tools.

Java is further unique for its bolas which, so far, were not recovered in other islands, even Sumatra where heavy-duty tools are present. At Sangiran, the full production sequence of these spheric tools is present, from the polyhedron through the spheroid and to the bola. It somehow seems that each island could have developed its own specificities, potentially in relation to the locally available raw material. In Sumatra for instance, the handaxes are unique and significantly differ from the Pacitanian or the Arubo bifacially worked artefacts. It is therefore interesting to note that Sumatra and Java appear more distant to each other when one considers the morphologies of the handaxes than Luzon and Java. Yet, while those two latter islands were never connected to each other, Sumatra and Java used to be at several occasions.

Although, like in the Soa Basin, LCTs were not recovered in Kalinga, beyond the evidence they were present at some point in time on Luzon Island, it seems that this absence has been easily overcome. It is indeed worth to be mentioned that the absence of any heavy-duty tools at Kalinga did not prevent the butchers from trying to break the two rhino humeri. In one case they succeeded while they failed for the other, with notably no second attempt (Ingicco *et al.*, 2018).

The antiquity of the LCTs and the small flakes is no longer in question since the discovery of both types *in situ* at Ngebung 2. At Mata Menge, although the archaeological material is of small dimensions, Moore and Brumm (2007) considered core-tools and small flakes to be part of the same production strategies. Yet, some differences exist whenever one compares reduction strategies for the flakes between assemblages with core-tools and assemblages without any. While the Sangiran flakes have been part of a short reduction sequence with little if no preparation of the core as evidenced by the proportion of cortical butts, the smaller flakes from the Pacitanian assemblage have, in contrary, faceted butts evidencing some preparation of the cores. The distinction between short and long reduction sequences has to be put in relation to the size of the blanks, with larger blanks allowing a longer sequence.

8. The chronology in question: concluding remarks on the technocomplexes present in Island Southeast Asia

It seems from this rapid overview that the Lower Palaeolithic islanders took full advantage of their surrounding environment and to a certain degree of adaptability. Within the Pacitanian of the Baksoka River, two chaînes opératoires were used, like in Mata Menge, débitage on large flakes and shaping on nodules mainly and cobbles. Whenever they had access to large boulders like in Sumatra,

they shaped massive LCTs. On the contrary, whenever the cobbles were of small dimensions, small flakes were produced such as in Sangiran, Soa and Cagayan. Whenever the raw material was of poor quality for the knappers, bipolar on anvil reduction was adopted such as in Kalinga and Mata Menge.

These toolmakers even used stegodon tusks to produce a cleaver at Ngebung 2. Yet, considering the propensity of heavy-duty tools produced from large flakes in the Baksoka River assemblages, the absence of cleavers, which are by definition Large Cutting Tools made from a flake (Tixier, 1956) is notable. While cleavers are common in India along with handaxes, like in Eastern Africa, they are notably rare in island Southeast Asia (Garanger, 1992). The small collections at hand for some places may explain, based on this observed rarity, their total absence on some islands.

The handaxe morphologies from Sumatra and even Java (Sémah et al., 2014; Simanjuntak et al., 2010) or Sulawesi (Keates and Bartstra, 2001), can be categorized as archaic, massive, heavy, dense, cortical and mostly very thick (weakly shaped) compared to African or Indian pieces that display varied and changing forms over the long Quaternary time (Brumm and Moore, 2012; Simanjuntak and Forestier, 2009, 2008). In many ways, Sumatra appears as another world. Yet, it definitely belongs to the Acheulean technocomplex, such as Java Island does, while this is less evident for the other islands. Whenever taken independently, the occurrence of Lower Palaeolithic sites in Island Southeast Asia, such as in Flores, Luzon and Sulawesi, where the assemblages are limited to small flakes and the notable absence of LCTs, it would seem reasonable at the moment not to apply the European and African standards in cultural seriation, by referring to Oldowan/Acheulean or to Mode 1/Mode 2. Each of these islands might have had its own evolutionary trend with its own rhythm.

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Captions

Figure 1 - Physiographic map of Southeast Asia with a sea level 110 m lower than present, approximating its configuration 790 Ma (Past Interglacials Working Group of PAGES, 2016), showing rivers, palaeorivers, lakes and palaeolakes. Land basemap from ESRI ArcGis and sea basemap from Gebco Nov. 2021.

Figure 1 - Carte physiographique de l'Asie du Sud-Est avec un niveau de la mer inférieur de 110 m par rapport au niveau actuel, se rapprochant de sa configuration à 790 Ma (Past Interglacials Working Group of PAGES, 2016), montrant les rivières et les paléorivières, les lacs et les paléolacs. Carte de base du territoire provenant de ESRI ArcGis et carte de base des mers provenant de Gebco Nov. 2021.

Figure 2 - Handaxes from Island Southeast Asia. **a-b.** Pacitanian handaxes from the Baksoka River and its tributaries on Java Island; **c.** Arubo 1 handaxes from Luzon Island (courtesy A.F. Pawlik); **d.** the handaxe discovered on Palawan Island (photo A.F. Pawlik, courtesy V.J. Paz); **e.** Ogan River handaxe on Sumatra Island; **f.** trihedral pick from Ogan River on Sumatra Island.

Figure 2 - Bifaces d'Asie du Sud-Est insulaire. a-b. Bifaces pacitaniens de la rivière Baksoka et de ses affluents, île de Java ; c. Bifaces d'Arubo 1, île de Luzon (avec l'aimable autorisation de A.F. Pawlik) ; d. Biface découvert sur l'île de Palawan (photo A.F. Pawlik, avec l'aimable autorisation de V.J. Paz) ; e. Biface provenant de la rivière Ogan sur l'île de Sumatra ; f. Pic trièdre de la rivière Ogan sur l'île de Sumatra.

Figure 3 - Heavy duty tools from Island Southeast Asia. **a.** andesite cleaver from Ngebung 2 excavation on Java Island; **b.** cleaver from the Ogan River on Sumatra Island; **c.** large flake from the Ogan River on Sumatra Island; **d.** chopper from the Ogan River on Sumatra Island; **e.** bola from Ngebung 2 excavation on Java Island; **f.** flake on *Stegodon* tusk from Ngebung 2 on Java Island.

*Figure 3 - Outils lourds provenant de l'Asie du Sud-Est insulaire. a. Hachereau en andésite provenant des fouilles de Ngebung 2 sur l'île de Java ; b. Hachereau provenant de la rivière Ogan sur l'île de Sumatra ; c. Grand éclat provenant de la rivière Ogan sur l'île de Sumatra ; d. Chopper provenant de la rivière Ogan sur l'île de Sumatra ; e. Bola provenant des fouilles de Ngebung 2 sur l'île de Java ; f. Éclat sur une défense de *Stegodon* provenant de Ngebung 2 sur l'île de Java.*

Figure 4 - Flakes from island Southeast Asia. **a-c.** three “Sangiran flakes”. The first one has continuous retouches on one of its edges (white dots); **d-f.** three flakes from Mata Menge excavation on Flores Island (photos M.W. Moore, courtesy M.W. Moore and A. Brumm); **g-h.** two flakes from Talepu excavation on Sulawesi Island (courtesy G.D. van den Bergh); **i-j.** two flakes from Kalinga excavation on Luzon Island.

Figure 4 - Eclats de l'Asie du Sud-Est insulaire. a-c. trois "éclats de Sangiran". Le premier présente des retouches continues sur l'un de ses bords (points blancs) ; d-f. trois éclats provenant des fouilles de Mata Menge sur l'île de Flores (photos M.W. Moore, avec l'aimable autorisation de M.W. Moore et A. Brumm) ; g-h. deux éclats provenant des fouilles de Talepu sur l'île de Sulawesi (avec l'aimable autorisation de G.D. van den Bergh) ; i-j. deux éclats provenant des fouilles de Kalinga sur l'île de Luzon.

Figure 5 - A comparison of the flake dimensions from Island Southeast Asia, recovered from surface findings (Cagayan, Pacitan, Cabenge) and excavated sites (Kalinga, Talepu, Mata Menge, Wolo Sege). Data from Bakara (2007), Brumm et al. (2010a; 2010b), Keates and Bartstra (2001), van den Bergh et al. 2016b.

Figure 5 - Comparaison des dimensions des éclats de l'Asie du Sud-Est insulaire, provenant de découvertes de surface (Cagayan, Pacitan, Cabenge) et de sites de fouilles (Kalinga, Talepu, Mata Menge, Wolo Sege). Données provenant de Bakara (2007), Brumm et al. (2010a; 2010b), Keates and Bartstra (2001), van den Bergh et al. 2016b.









